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Fertilizer Requirements Of Irrigated Alfalfa

Ensuring soil fertility levels are adequate is one of the factors that managers must consider when they grow irrigated alfalfa in southern Alberta. Irrigated alfalfa produce 5 to 6 tons of dry matter per acre if it receives sufficient amounts of water and nutrients. Climate, soil type and management will all affect the yield a producer can expect from an alfalfa crop.

Alfalfa has a high demand for nutrients compared to other crops. Table 1 gives the approximate amount of each nutrient removed per ton of dry matter alfalfa.

Table 1. Nutrient removal per ton of dry matter alfalfa.

Nutrient	Amount removed (lb/ac)
Phosphorus (P)	4
Phosphate (P_2O_5)	10
Potassium (K)	40
Potash (K_2O)	50
Calcium (Ca)	30
Magnesium (Mg)	5
Sulphur (S)	5
Boron (B	0.08
Copper (Cu)	0.01
Iron (Fe)	0.3
Manganese (Mn)	0.1
Molybdenum (Mo)	0.002
Zinc (Zn)	0.05

Soil testing

Soil testing is the most reliable way to identify which nutrients may be deficient in a soil. This will permit a producer to develop a balanced fertilizer program. A field should be soil sampled (see Agdex 531-1), before an alfalfa crop is seeded, and tested for the levels of plant-available nutrients. Eroded knolls and fields that have been levelled recently should be sampled separately because they may require higher applications of some nutrients.

To ensure that alfalfa remains productive, soil fertility levels should be monitored throughout the life of the stand.

Nitrogen

Alfalfa is a legume that can "fix" its own nitrogen (N) with the help of *Rhizobium meliloti*, a bacteria that lives in association with alfalfa roots. The bacteria converts nitrogen gas (N_2) in the air into a form that plants can use. A 5 ton/ac alfalfa crop will fix up to 250 lb/ac of nitrogen per year. Because the soil in southern Alberta is low in N-fixing bacteria, alfalfa seed must be inoculated with the *R. meliloti*. Alfalfa seed is often pre-inoculated before sale. Store inoculated seed in a dark, cool place to ensure the live bacteria survive until seeding time (see *Inoculation of Legume Crops*, Agdex 100/23-1).

Poor N-fixation can be the result of improper inoculation. In some cases N-fixation declines after four or five years. Poor stands should be broken and seeded to an annual crop for several years before being reseeded with a recommended variety of alfalfa.

Alfalfa can recover nitrogen that has leached below the effective rooting depth of annual crops (about 1 metre) because it is a deep rooted crop.

Phosphorus

Alfalfa has a high requirement for phosphorus (P). A 5 ton/ac crop requires approximately 50 lb/ac of P_2O_5.

Soils in southern Alberta are naturally low in plant available phosphorusResidual P levels in irrigated soils of southern Alberta vary because many fields have received phosphate fertilizer regularly for years, so a soil test should be done before applying phosphorus.

A large batch application of phosphate applied prior to establishing alfalfa is the most effective way to add P. An application of 200 lb/ac of P_2O_5 will meet crop requirements for four to five years. Phosphate fertilizer can be either banded or broadcast-incorporated prior to seeding alfalfa. In an Alberta Agriculture survey of 100 alfalfa fields, two-thirds of them tested low in soil P, while only one-third tested low in tissue P. Further research is

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needed to accurately determine when alfalfa will respond to added P fertilizer.

Potassium

Alfalfa has a high requirement for potassium (K). Most southern Alberta soils are high in available K (300 lb/ac of ammonium acetate extractable K). Potassium is normally only deficient on very sandy soils and a soil test will help to determine if K levels are deficient. The Alberta Agriculture survey of alfalfa fields also showed that no field soil-tested low in K while one-third tested low in tissue K. Further research is needed to accurately determine when alfalfa might respond to added K fertilizer.

Sulphur

Alfalfa has a high requirement for sulphur (S), but irrigated soils are almost never deficient in S. Irrigation water naturally contains dissolved sulphate-sulphur (SO_4-S), which is the form required by plants. For every 12 inches of irrigation water applied, approximately 30 lb/ac of SO_4-S is also added, which meets crop requirements.

Micronutrients

No responses to micronutrient fertilizers have been observed in alfalfa in southern Alberta. Boron (B) is the only micronutrient that may become a problem. Boron deficiencies first appear on sandy, low organic matter soils. Extreme care is required when using boron because a 5 lb/ac application can be toxic to alfalfa as well as other crops. Therefore, adding micronutrient fertilizers is discouraged until a soil fertility specialist is consulted.

Fertilizing established alfalfa

Nitrogen

Nitrogen fertilizer can increase the yield of alfalfa stands when N-fixation is inadequate. However, no research has been done to determine if applying N fertilizer on alfalfa is economical. Application of N fertilizer favors the growth of grasses, which may eventually dominate the stand. Applying nitrogen fertilizer on good alfalfa stands is not recommended.

Phosphorus

If phosphate was not applied before seeding or is limiting production, a grower may consider an annual maintenance application of 50 lb/ac of P_2O_5 to meet crop removal rates. This may not be as effective as pre-plant incorporated P because P is immobile and moves very slowly into soil. However, irrigated alfalfa has feeder roots, near the soil surface, that can take up P with reasonable efficiency. Broadcasting is presently the only practical method of in-crop fertilizer application and should be done very early in the spring. Table 2 presents general phosphate fertilizer recommendations. New methods of high pressure liquid injection and spoke wheel injection are under study and may offer more effective means of phosphate application to established fields in the future.

Table 2. Phosphate fertilizer recommendations for irrigated alfalfa.

Soil Test Phosphorus (P) (0-15 cm depth) (lb/ac)	Phosphate (P_2O_5) Recommendation (lb/ac)
0-10	60
10-20	50
20-30	45
30-40	40
40-50	35
50-60	30
60-70	25
70-80	20
>80	0

Note: Based on the Miller-Axley soil P test method.

Potassium

In fields testing deficient in potassium, annual applications of potash (K_2O) fertilizer may be necessary and the soil test recommendation should be followed (Table 3).Occasionally, fields that have sufficient K soil levels will respond to a 50 lb/ac application of K_2O fertilizer in early spring if conditions are unseasonably wet and cool. Under these conditions, soil K is less available and less mobile in the soil. However, responses to K_2O are uncommon. Applications should first be tried in carefully marked test strips to determine if a response actually occurs.

Table 3. Potash fertilizer recommendations for irrigated alfalfa.

Soil Test Potassium (K) (0-15 cm depth (lb/ac)	Potash (K_2O) Recommendation (lb/ac)
0-25	260
25-50	220
50-75	180
75-100	150
100-125	125
125-150	100
150-175	75
175-200	50
200-225	25
225	0

Note: Based on the ammonium acetate soil K test method.

Manure

Manure is used as a fertilizer on established alfalfa fields. It can burn leaves which in turn reduces the yield and quality of alfalfa. Manure application equipment may reduce yields by compacting soil and damaging alfalfa crowns.

Because the nitrogen in manure may stimulate grass and even weed growth in alfalfa stands, manure is better used on non-legume crops. If no other land is available, then the spread manure on the oldest alfalfa stand or the one with the most grass in it. Solid manure should be well broken up and applied at a rate no higher than 10 tons/acre. Apply it immediately after a cut has been removed so the manure contacts the soil rather than the crop. The manure should be applied on soil that is firm and relatively dry to reduce soil compaction. Irrigation after a manure application will minimize crop damage and reduce nitrogen loss.

Plant tissue analysis

Plant tissue analysis will provide additional information on soil fertility and the nutritional health of the crop. At the bud-stage, healthy alfalfa plants contain a minimum of 3.0 per cent nitrogen, 0.2 per cent phosphorus, 1.7 per cent potassium and 0.2 per cent sulphur. Table 4 shows the levels of each nutrient in the top 15 cm of plant tissue at 5 per cent bloom.

Table 4. Levels of nutrients in the top 15 cm of alfalfa tissue at 5 per cent bloom.

Nutrient	Low	Sufficient	High
		Per cent (%)	
Nitrogen	<3.0	3.0-5.0	5.0
Phosphorus	<0.20	0.20-0.70	0.70
Potassium	<1.70	1.70-3.80	3.80
Calcium	<0.25	0.25-3.0	3.0
Magnesium	<0.20	0.20-1.0	1.0
Sulphur	<0.20	0.20-0.50	0.50
		Parts per million (ppm)	
Boron	<20	20-80	80
Copper	<5	5-30	30
Iron	<20	20-250	250
Manganese	<20	20-100	100
Molybdenum	<0.5	0.5-5.0	5.0
Zinc	<20	20-70	70

Tissue analysis can determine when nutrient deficiencies are present before visual symptoms appear. Coupled with soil tests, tissue analysis allows producers to establish a more comprehensive fertilizer management program for alfalfa.

For additional information on fertilizing irrigated alfalfa contact the:

- district agriculturist office
- Agricultural Soil and Animal Nutrition Laboratory, Edmonton, 427-6361.
- Forage Specialist, Lethbridge, 381-5124
- Soil Fertility Specialist, Lethbridge, 381-5126

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